# The Effect of Ethnicity on Left Ventricular Adaptation to Exercise

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**Abbreviations:** BA- black athlete, HCM-hypertrophic cardiomyopathy, LV-left ventricular, LVH- left ventricular hypertrophy, LWMI- left ventricular mass index, RWT- relative wall thickness, SCD-sudden cardiac death, WA- white athlete.

Ethnicity is a major determinant of cardiac adaptation to exercise. Black athletes (BAs) demonstrate more profound electrical and structural changes, than white athletes (WAs), which manifest on the 12-lead ECG and echocardiogram (1,2). It is well established that BAs develop greater left ventricular hypertrophy (LVH) in response to exercise, compared to WAs, creating a larger overlap between physiology and hypertrophic cardiomyopathy (HCM). The issue is further compounded by the fact that BAs are at increased risk of exercise-related sudden cardiac death (SCD) with HCM accounting for a significant proportion of cases (3). The growing number of elite black sportsmen and women has intensified efforts to correctly identify those at risk. Left ventricular (LV) geometry has been postulated as a more accurate tool compared to absolute LV wall thickness in differentiating physiological LV hypertrophy from HCM. Although LV geometry has been well characterised in WAs (4) there is a paucity of data in male BAs and even less data in female BAs. This study aimed to establish the influence of black ethnicity on LV geometry and to derive ethnicity-specific normative values for relative wall thickness (RWT).

This retrospective, cross-sectional cohort study included 640 BAs (80% male, mean age 22±5 years) and 1083 WAs (59% male, mean age 22±6 years) who underwent pre-participation screening. Ethnicity was self-reported by each athlete. Athletes were assessed with a health questionnaire, ECG and echocardiogram. All athletes included in the study, were asymptomatic, demonstrated a normal ECG and were free from cardiovascular disease. Athletes participated in a variety of, predominantly mixed and dynamic, sporting disciplines at regional and national level. In WAs, the most popular sports were swimming (11%), cricket (9%), football (8%) and rowing (8%). In BAs the most popular sports were football (31%), athletics (25%) and boxing (9%). LV remodelling was categorised, based on RWT and LVMI (left ventricular mass index), as normal, eccentric hypertrophy, concentric remodelling or concentric hypertrophy (**Figure 1**). Results are presented as percentages for categorical data and mean±SD for continuous data. Reported upper thresholds were defined as two SDs above the mean. Variables correlated with the dependent variable in univariate analysis were entered into a multivariate model. Logistic regression analysis was used to determine the factors independently associated with LV remodelling. Ethical approval was granted by the National Research Ethics Service, Essex 2 and University Hospital Lewisham Research Ethics Committee in the United Kingdom.

Male athletes exhibited higher RWT (BAs: 0.37±0.07 vs 0.36±0.06; p=0.008, WAs: 0.36±0.04 vs 0.35±0.04; p<0.001) and LVMI (BAs: 104.6±24g/m$^2$ vs 82.1±16.7g/m$^2$; p<0.001, WAs: 101±21g/m2 vs 83±17g/m$^2$; p<0.001) compared to female athletes, across both ethnicities. Male BAs demonstrated higher RWT (0.37±0.07 vs 0.36±0.04; p=0.002 and LVMI (104.6±24g/m2 vs 101±21g/m2; p=0.02) than male WAs. In contrast, female BAs exhibited higher RWT (0.36±0.06 vs 0.35±0.04; p=0.03 but similar LWMI (82.1±16.7g/m$^2$ vs 83±17g/m$^2$; p=0.56) to female WAs. Most athletes demonstrated normal LV geometry (**Figure 1**). Eccentric hypertrophy was present in 21% (n=91) of female WAs, 19% (n=125) of male WAs, 17% (n=86) of male BAs and 14% (n=18) of female BAs. Concentric remodelling or hypertrophy was present in 20% (n=102) male BAs, 12% (n=77) of male WAs, 9% (n=11) of female BAs and 7% (n=34) female WAs. In a multivariate model (including age, gender, ethnicity and type of sport (static, dynamic and mixed sports), black ethnicity was the only predictor of concentric remodelling or hypertrophy (OR 1.9, CI (1.5-2.6), p<0.001). The upper thresholds for RWT (two SDs above the mean) were: 0.51 for male BAs, 0.48 for female BAs, 0.44 for male WAs and 0.43 female WAs.

This study shows that male BAs are more likely to exhibit concentric remodelling or hypertrophy in comparison to white counterparts. It also provides important information regarding cardiac remodelling in female BAs, who exhibit similar LV remodelling to male BAs. A possible putative mechanism to explain differences in cardiac remodelling among

BAs and WAs is that of race related polymorphisms which may predispose to LVH (5). It is also possible that there are quantitative and qualitative differences to the pattern of training among BAs that may promote LVH. Our study was subject to the limitations of a single centre retrospective study. The findings would potentially not be applicable to older athletes who may demonstrate a propensity to vascular rather than cardiac remodelling (6). Although prevalence of hypertension in young athletes is low, blood pressure was not consistently recorded across screening events. Moreover, BAs and WAs did not engage in the same type of sport and this may have determined at least partly the observed differences in LV geometry.

In conclusion, one in five male BAs exhibit concentric remodelling or hypertrophy, with significantly raised RWT and LVMI. Our findings suggest that in WAs, a RWT of >0.45, commonly used as the upper limit of normal in clinical practice, should raise suspicion of HCM. In contrast, a RWT of up to 0.51 for male and 0.48 for female BAs may be physiological, and in the absence of symptoms, family history of HCM or premature SCD, ECG abnormalities or additional echocardiographic indices, does not require further investigations.

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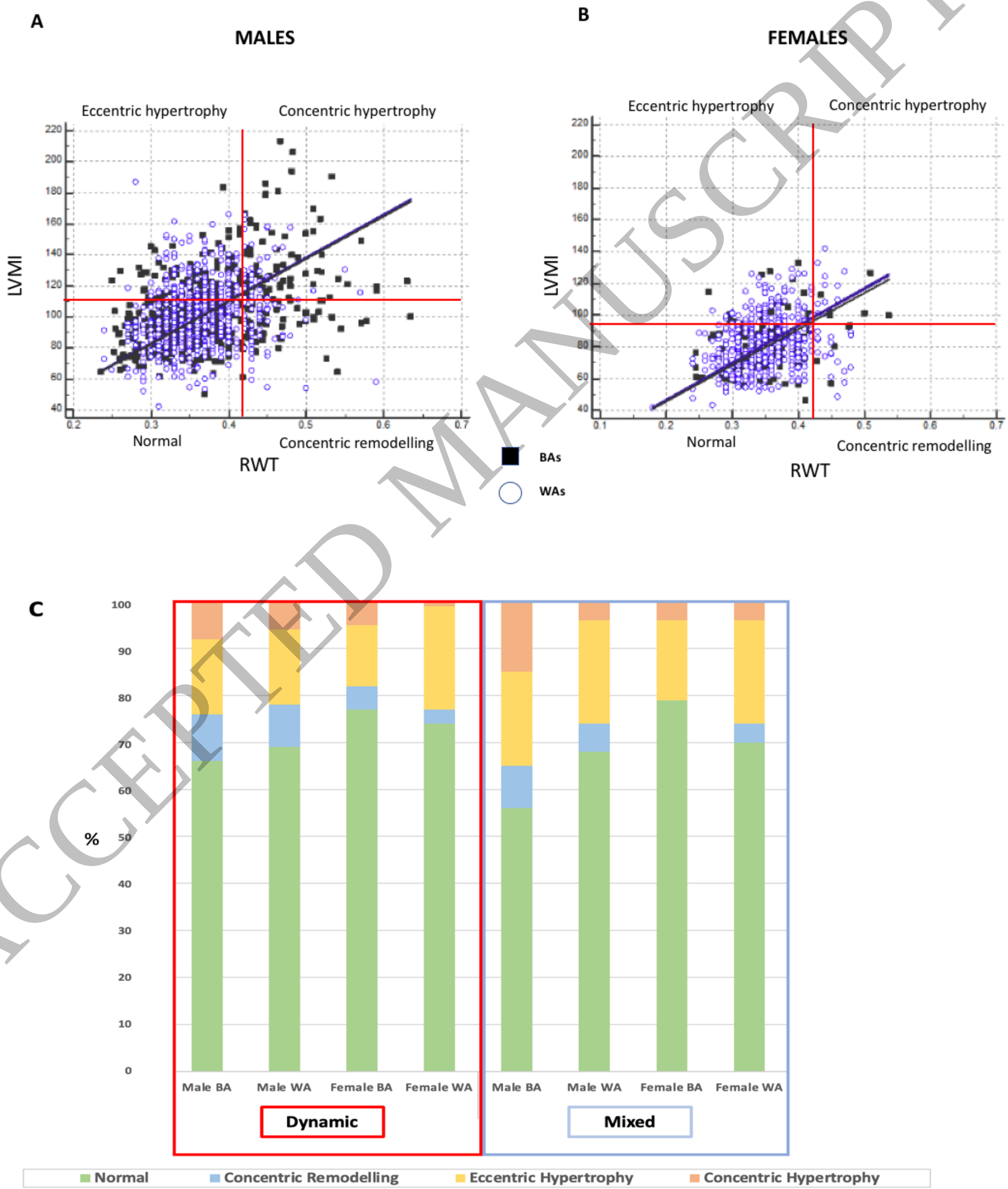

**Figure 1.** Distribution of LV geometry types in white and black, male (A) and female (B) athletes. Black individuals are represented by a square, and white individuals by a circle. The red lines on each graph correspond to normal RWT (<0,42) and LVMI (<95g/m$^2$ in women and <115g/m$^2$ in men) values (Lang R et al. Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the ASE and the EACVI. Eur Heart J Cardiovasc Imaging 2015;16:233-271). RWT= relative wall thickness, LVMI= left ventricular mass index. (C) LV geometry in black and white athletes according to dynamic or mixed sports participation. BA= black athletes, WA= white athletes.

## Data availability statement

The data underlying this article cannot be shared publicly due to the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author.